Dynamics of the model with differentiation

Include cell differentiation where reproduction happens in the next compartment

The model tracks the movement of the cells from compartments $X_n \to X_{n-1} \to X_{n-2} \to \ldots \to X_0$
All cells in compartment X_0 are *off* cells which all others are *on*
The switch from $X_0 \to X_n$ occurs with probability μ

In this notebook we extend the model to include differentiation. Thus each cell can thus undergo four processes:

1. Differentiation
   $x_i \to x_{i-1} + x_{i-1}$ with probability ϵ
2. Death
   $x_i \to \phi$ with probability d
3. Switch to X_n
   $x_i \to x_n$ with probability μ (valid only for $i = 0$ and $\mu = 0$ otherwise)
4. Reproduce
   $x_i \to x_i + x_i$ with probability (1-ϵ-d-μ)

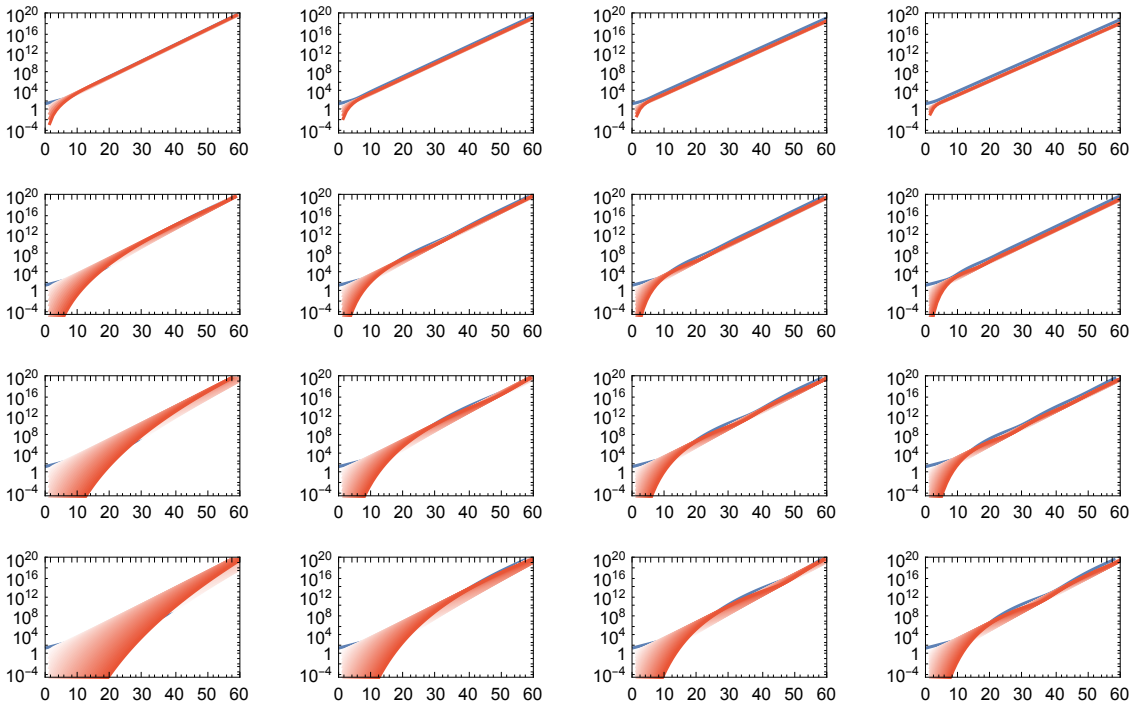
As compared to the main text now we represent the rates with probabilities of each process to materialise.
Thus the interpretation of the rates changes but the essence of the model stays the same.
The deterministic dynamics of the process can then be described by the following three equations:

$\dot{x_n} = x_n(1 - 2\,\epsilon - 2\,d) + \mu\, x_0$
$\dot{x_i} = x_i\,(1 - 2\,\epsilon - 2\,d) + 2\,\epsilon\, x_{i+1}$ (for $i = 1,\ldots,n-1$)
$\dot{x_0} = x_0(1 - 2\,d - 2\,\mu) + 2\,\epsilon\, x_{n-1}$

Running the model for three cycles, each lasting for 100 time-steps.

The plots below show the population size in the on and off compartments for different leaching rates (rows) and different memory sizes (5,15,25,35). This corresponds to the main text figure *Transient dynamics in multi-state memory (b).*

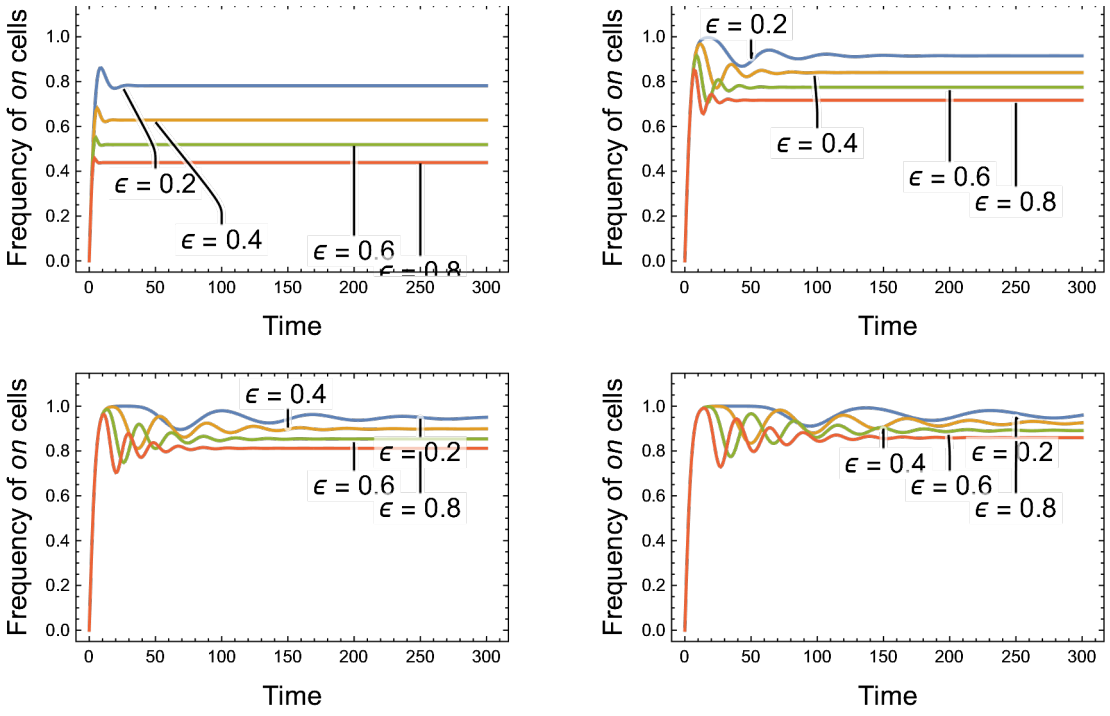
Out[•]=



Transient dynamics for different number of compartments

The plots show the increase in over(under) shoots as the number of compartments is increased from 5, 15, 25, 35

Out[•]=



Transient dynamics of multi-state memory for a given ϵ

Focus on only the first cycle which runs for 100 time steps.

Out[•]=